General Application Name: Public Works/Service Authority

Product / Service / Function Name: NPDES Program

P/S/F Description:

The National Pollution Discharge Elimination System (NPDES) Permit Program was introduced in 1972 as a way to curb the degradation of U.S. surface water quality due to various forms of pollution. As authorized by the Clean Water Act, the National Pollution Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources can be described as single locations that discharge storm water, such as storm water pipes outlets or man-made storm drainage ditches. This is in contrast to non-point source pollution, such as runoff from an agricultural field.

The NPDES permits are not required for individual homeowners that are connected to a municipal sewer system or have a septic system in place. Additionally, homes that do not generate a surface discharge are not required to obtain a NPDES permit. Any industrial, municipal or other type of facility that does have a discharge to surface waters is required to obtain a NPDES permit. To comply with NPDES requirements, municipalities often create a monitoring program to continuously test the discharge.

GIS technology is ideal for managing NPDES permitting and monitoring. By locating the sampling points "on the map," planners can begin to see relationships between the sampling results and features on the physical landscape while ensuring they comply with regulations. It can also blend well with the storm water management program.

Product / Service / Function

1. Spatial Data

Minimum Requirements

General Description	Data Layer
Site Data	Stormwater Outfall Locations
	Stormwater System (pipes, inlets, etc.)
	Stormwater drainage boundaries
Planimetric Data	Tax Parcels
	Buildings
Natural Features	Open Water
	Hydrology
Transportation	Street Centerlines
Socio-Political Data	Municipal Boundaries

Optional Enhancements

General Description	Data Layer
Site Data	Sampling Locations
Planimetric Data	Zoning Districts
	Land Use

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Natural Features	100-Year Floodplain
	Vegetation
	Contour Lines
Transportation	Railroads
Socio-Political Data	Zip Code Boundaries
	Neighborhoods & Subdivisions
Other Data	Digital Orthophotography

2. Attribute Data

Minimum Requirements

General Description	Field Name
Stormwater Sampling Data	Sampling Frequencies
	Sampling Parameters

Optional Enhancements

General Description	Field Name
Stormwater Sampling Data	Sampling Procedures
	Sampling Results
	Sampler's Name
	Water Depth
	Water Temperature
	Water pH
	Water Depth
	Water Flow Rate
	Water Flow Volume

3. Data acquisition Options (integrated with VBMP digital orthos)

The foundation for a GIS-based NPDES monitoring program is an accurate inventory of the storm water system (see the Storm Water Drainage System Inventory topic). The critical data needed for NPDES permitting is the locations of all sampling stations and their associated test results. These results are most likely stored in a database because of the sheer volume of data that is collected every year for the NPDES program. As long as each sample is tagged with the sampling station ID, the results can be linked directly to the GIS data layer of sampling stations. The most efficient way to gather the locations of the sampling stations is through a GPS survey. Additionally, a municipality may want to keep photographs of each outfall location. These photos can be "hotlinked" to the sampling station in the GIS for easy viewing.

Other planimetric data such as utilities, building footprints, land use, streets, etc. are typically maintained at the county or city level. Street centerline data layers of varying qualities can be obtained from a number of vendors. The market is relatively competitive, and prices will vary with quality of the data. Relevant vendors that provide this kind of spatial data on a regional and national scale include: NAVTECH <www.navtech.com>, GDT <www.geographic.com>, and TeleAtlas <www.teleatlas.com>.

Additional spatial data layers can be obtained through the Internet from various government sources. Municipal boundaries and similar layers can be obtained in digital format through the U.S. Census Bureau <www.census.gov>. Floodplains can be obtained through the FEMA Web site <www.fema.com>.

Regardless of the source of the data, each data layer used for a GIS-based NPDES program monitoring application should be consistent with the Virginia Base Mapping Project (VMBP) orthophotography. This is vital for data consistency across the state and facilitates data sharing across jurisdictional boundaries. The digital orthophotography provides an excellent base data layer on which to symbolize sampling data and plan future sampling routes or inspections.

4. Data conflation Options (integrated with VBMP digital orthos)

Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically "corrected" through geometrical and rotational transformations so that the different layers can be overlaid on one another. Also called "rubber-sheeting," this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation.

Data collected for an NPDES program should use the VBMP orthophotography for the conflation process. The orthophotography will give the user a unique perspective on the spatial aspect of collecting runoff samples as features can be seen and interpreted from the photos. Also, keeping data consistent with the VBMP orthos allows for consistency across the state and facilitates data sharing across jurisdictional boundaries.

5. GUI / programming options

There are many options for developers of a GIS-based NPDES application. The following are three options:

- Standard GIS desktop application that can be customized to the user's needs
- Existing commercial application
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS application often requires a significant amount of training and customization. Whereas the initial cost may be lower, the time invested in learning these solutions may generally increase the overall expense of implementation. However, standard GIS packages deliver more robust data integration, analysis, and cartographic capabilities than do other specialized commercial applications. They have a greater user support infrastructure that allows users to overcome problems quickly.

Standard GIS Software Vendors:

Vendor	**Software**	**Web Address**
ESRI	ArcView 3.x	http://www.esri.com
ESRI	ArcGIS 8.x	http://www.esri.com
MapInfo	Professional 7.0	http://www.mapinfo.com
Intergraph	GeoMedia 5.0	http://www.intergraph.com/gis
Autodesk	Map 5.0	http://www.autodesk.com

There are an increasing number of vendors developing and implementing storm water management software that may aid in NPDES permitting. These products may cost more than standard GIS solutions because of the customization that is required to fit the application into the agency's business practices and/or connect to its data source. The advantage is that a tailored application provides just the functionality that is needed, decreasing the overall application overhead common to industry-standard GIS software. Options for using an existing, commercial storm water management system include those listed in the following table:

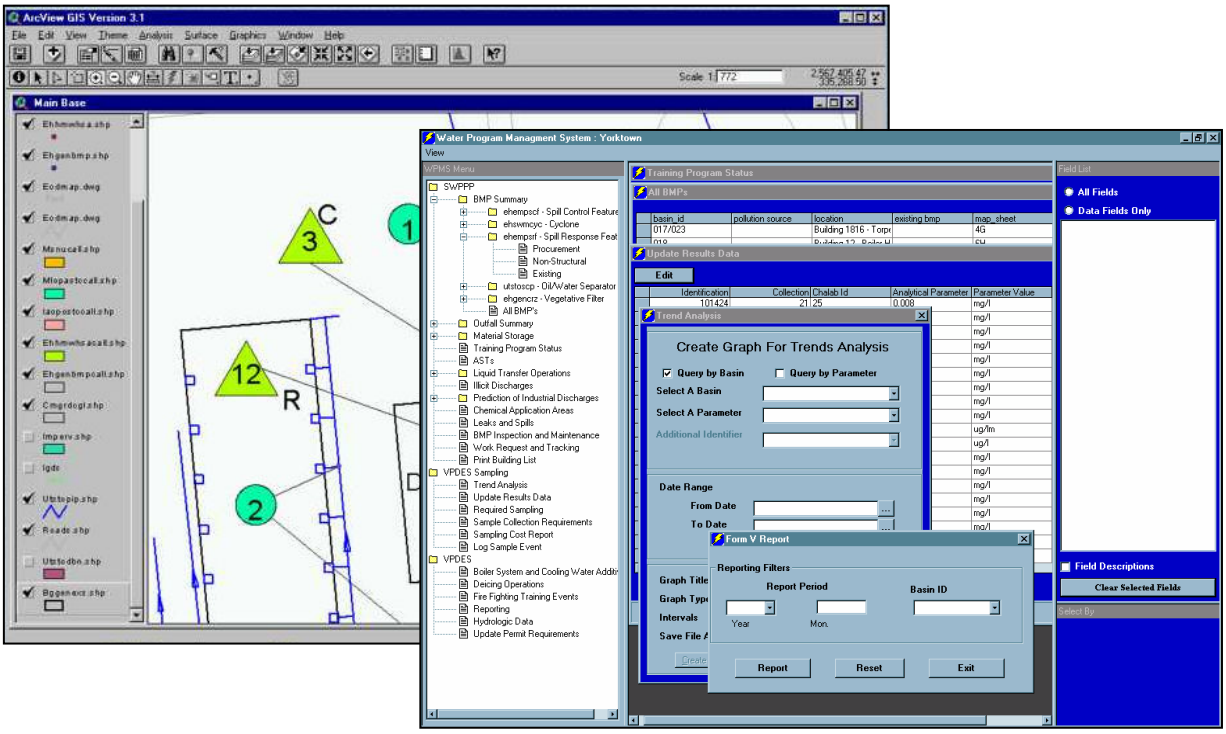
Commercial Software:

Vendor	**Product**	**Web Address**
Azteca	CityWorks	http://www.azteca.com
CarteGraph	WATERview	http://www.cartegraph.com
Hansen	Hansen 7.5	http://www.hansen.com
GBA Master Series	GBA Storm Master	http://www.gbamasterseries.com/
ASIST.net	ASIST	http://www.asist.net/

The final option for developing and implementing a GIS-based NPDES application is to contract with a consultant. This option makes certain that a product will fulfill an agency's requirements. A consultant will be able to develop an application that works with the wide range of hardware and software that are currently in use within local governments within Virginia. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

There are several options for functionality that should be considered in a GIS-based NPDES application. The following is a list of possibilities:

- Prepare individual and general NPDES permits
- Locate potential polluting properties among industrial, commercial or agricultural areas
- Identify residential properties that could be contaminated by pollutants in the event of a spill
- The ability to display, update, and query tabular and spatial data about sampling stations and test results
- Calculate the volume of rainfall runoff for each drainage area and the volume of runoff for each watershed based on the cumulative runoff from each drainage area
- Estimate the annual, seasonal, or per storm pollutant loadings from various combinations of storm drains and/or drainage areas
- Assist in the identification of the sources of pollutants by spatially locating potential polluters based on land use category and selected pollutants



A GIS-based water program management system that analyzes samples and generates reports and graphs.

6. Internet Functionality and options

The Internet has proven itself as a viable solution for local governments to centralize the maintenance and management of services and data. As more local governments are implementing Web-based solutions, they are finding that the Internet requires them to change the nature of an application or its usefulness. Through the flexibility of an Internet solution, software can be easily updated, and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

If a local government so chooses, they can deploy a Web GIS application to allow citizens of their community to view maps of the NPDES sampling stations along with the reports on discharge. Also, maps of the storm water drainage system in general can be placed on the Web. GIS software vendors have products that can be customized in-house or by a consultant to provide Web GIS applications on the Internet, over an intranet or via wireless network. The table below shows GIS vendors and their Internet mapping solutions.

GIS Internet Solutions

Vendor	Internet Software	Web Address
ESRI	ArcIMS	http://www.esri.com/software/arcims
MapInfo	MapXtreme, MapX	http://www.mapinfo.com
Intergraph	GeoMedia WebMap	http://www.intergraph.com/gis/gmwm
Autodesk	MapGuide	http://www.autodesk.com

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7. Minimum Technical Requirements

Minimum Technical Requirements

An NPDES program mapping system can be used on a single, stand-alone workstation. This workstation would have a hard drive that stores all of the spatial data layers, as well as a database containing a copy of all of the sampling records for the identified user. A typical workstation running off-the-shelf software should have the following minimum specifications:

Processor:	Pentium 3, 450 MHz
RAM:	128MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional
Printer:	8x11 office-grade color printer

Optimum Technical Requirements:
A more complex application may require multiple components, including servers, desktop workstations, ruggedized laptops, and/or handheld devices. For either a client-server or a Web-based application, the system should rely on a fairly robust server computer and high-end workstations. Some examples specifications of the necessary equipment are listed below:

Server

Processor:	Min. 2x Processors, 1.7 GHz, 512K cache
RAM:	Min. 2x 512MB RIMMS
Hard Disk:	Min. 2x 80GB +RAID
Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

Workstation

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19”
Monitor 2:	17”
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

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Other Components

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

8. Administrative/Management Requirements

At the beginning of the project the assigned project manager should consider completing some, if not all of the following tasks that relate to the administrative requirements of a GIS-based NPDES application:

- Determine, with or without the assistance of a consultant, the preliminary vision and goals of the project.
- Determine the stakeholders of a NPDES program application (i.e. the Board of Supervisors, local/state environmental agencies, public works department, etc.) within their own jurisdiction and with larger government entities that they interact with.
- Coordinate an initial stakeholders meeting where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the stakeholders aware of the progress of the project.
- Develop a basic understanding of the available precedents in their region/state and research the available technologies that can be applied to their project.

Upon project completion, a simple desktop NPDES program and mapping application will require very little administrative support. Administrative tasks may include loading or upgrading new versions of the software or patches, providing for constant data flow from the sampling station data, and maintaining yearly support contracts on the hardware and software. However, once the system becomes distributed, there are various other management requirements that need to be fulfilled on a weekly or monthly basis.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone needs to maintain contact with the technology personnel that maintain these systems.
- The manager needs to put into place quarterly training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.
- The NPDES program and mapping only succeeds when it is implemented on a weekly basis with rigorous analysis and planning.

9. Cost – Cost/Benefit

Hardware	**Typical Unit Cost**
Minimum Workstation	$2,000
Optimum Workstation	$3,200
Laptop	$2,400
Web/FTP Server	$8,500
Database Server	$12,000
Data Warehouse Server	$18,000
Backup Server	$5,800
Printer (8x11 color)	$700
Printer (8x11 b/w production)	$2,000
Plotter	$12,000
Tape Library	$5,000
UPS	$700
Scanner	$1,500
Handheld	$300-$700
GPS equipment (for in-house use)	$5,000-$20,000

Software (all prices included license)	**Typical Unit Cost**
Standard GIS desktop software	$700-$10,000
Customized desktop vendor solution	$5,000-$15,000
Web-based vendor application	$15,000-$25,000
Customized web-based vendor solution	$20,000-$60,000

Miscellaneous	**Typical Unit Cost**
Training – focused vendor training (per person)	$700-$1,000
Training – general GIS	$700-$1,200
Licensing-desktop	$100-$500
Licensing-webapp (1st CPU)	$7,500-$12,000
Maintenance (per year)	$8,000-$15,000

10. Standards / Guidelines Summary

- Always maintain a unique identification number with every sampling station that is recorded with every sampling event.
- Standardize date and time conventions.
- Create a standard data collection procedure to ensure consistency.
- Collect sampling station locations at the same time the storm water drainage system is inventoried to save time and money.
- Consider combining the functionality of an NPDES application with the municipalities' storm water management program. This would be a more cost-effective solution.
- Maintain data in the VBMP standard coordinate system (Virginia State Plane, NAD 83, Survey Feet).
- Create metadata (standard information about GIS data) for each data layer. Metadata tracks the date, origin, coordinate system, and other such information for data layers.
- Develop a detailed Quality Assurance/Quality Control (QA/QC) procedure for reviewing the accuracy of the GIS data and its attributes.

11. Startup Procedures/Steps

There should be a minimum of eight steps involved with developing a GIS-based NPDES application, after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, GIS data, and personnel needs. It should include interviews of key individuals throughout the local government agency and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those interviewees that have little prior understanding of GIS. A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for a GIS-based NPDES application in the following areas: personnel needs, spatial data development needs, applicable spatial analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed system. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application or system.

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Analytical techniques that the application/system provides the user for NPDES functions
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system

The third task should be to compile or develop spatial data that can be used by the evolving application. Data can be gathered from a number of online sources, as well as county/city departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document and can be acquired through the methods described in Section 3 of this document.

On completion and acceptance of the functional requirements document and the development of the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The local government agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the local government agency remains a part of the development process throughout the project timeline.

When the application is nearing 100% completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system

alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches 100% completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful implementation of a GIS-based NPDES program application is ongoing technical support. The local government agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of an application.

12. Estimated time line and/or implementation (stand alone) schedule

Phase	**Duration**
RFP/Contract process (construction, posting, proposal acceptance, review, award of contract)	4 months - 1 year
Needs Assessment	1 month
Functional Requirements	1-2 months
Data Development	2-3 months
System Development and Testing	2-4 months
Installation and Testing	1 month
User Training	½ month
Plan for Future Development	¼ month
Ongoing Support	3 months

13. Best Practice Examples in Virginia

Oceana Naval Air Station
Engineering
1750 Tomcat Blvd
Virginia Beach, VA 23453
757-433-3131
http://www.nasoceana.navy.mil/

Yorktown Naval Weapons Station
Environmental Compliance Dept.
PAO PO Drawer 160
Yorktown, VA 23691
757-887-4939
http://www.nwsy.navy.mil

Prince William County
4361 Ridgewood Center Drive
Prince William, VA 22192,
703- 792-6666
http://www.co.fairfax.va.us/living/publicworks/default.htm